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Sampling Episode Report Norwegian Star Sampling Episode 6504

Executive Summary

March 2006

EXECUTIVE SUMMARY

Sampling Episode Report for Norwegian Star

This Sampling Episode Report describes the sampling and analysis activities to characterize wastewater (graywater and sewage) generated and discharged by the cruise vessel Norwegian Star while in Alaska waters. This sampling took place from August 8 through August 13, 2004, under the direction of the U.S. Environmental Protection Agency (EPA). The sampling program is part of EPA's data collection effort to evaluate whether to develop wastewater discharge standards, under 33 USC 1901 Note, for cruise vessels authorized to carry 500 or more passengers for hire when operating in the waters of the Alexander Archipelago or the navigable waters of the United States within the State of Alaska or within the Kachemak Bay National Estuarine Research Reserve. EPA will use information from the sampling of this vessel and three other cruise ships in Alaska to characterize wastewater generated and discharged by large cruise vessels with advanced wastewater treatment systems.

EPA selected the Norwegian Star to characterize the performance of the Scanship wastewater treatment system, an advanced wastewater treatment system that uses aerobic biological oxidation followed by dissolved air flotation and ultraviolet (UV) disinfection. Samples were collected of various wastewater sources (galley, food pulper, accommodations, and laundry wastewater), influent to the treatment system (combined graywater and sewage), influent to the UV disinfection component of the treatment system, effluent from the treatment system, source water, wastewater treatment sludge, and incinerator ash. Wastewater samples were collected for five consecutive 24-hour sampling periods, except for food pulper wastewater samples, which were collected for a single 24-hour sampling period.

Strap-on ultrasonic flow meters were installed near the sampling locations for the galley wastewater, accommodations wastewater, laundry wastewater, influent to treatment, and effluent from treatment to collect flow data and to trigger automatic sampling machines.

Various sample collection methods (composite by flow, grab, and grab composite) were used depending on the sampling point and the analyte. Tested analytes

included pathogen indicators (fecal coliform, *E. coli*, enterococci), classical pollutants, total and dissolved metals, volatile and semivolatile organics, pesticides, polychlorinated biphenyls, and dioxins and furans. Not all samples were analyzed for all target analytes.

The food pulper wastewater samples showed the highest concentration among graywater sources for the majority of analytes, most notably enterococci, oil and grease, nutrients, and solids. Galley wastewater samples had the highest concentration for 14 of the tested analytes, including *E. coli*, toluene, and several metals. Laundry and accommodations wastewater samples showed the highest concentrations for only 5 and 4 analytes, respectively.

Because of water conservation measures onboard cruise ships (such as vacuum toilets), key analytes such as pathogen indicators, biochemical oxygen demand (BOD₅), chemical oxygen demand (COD), and total suspended solids (TSS) are found at much higher concentrations in the influent to the Star wastewater treatment system than in typical domestic wastewater. Of the 54 metal analytes tested for, 28 were detected in every influent to treatment system sample. Among the 377 target analytes for volatile and semivolatile organics, pesticides, and polychlorinated biphenyls, only 8 were detected in any Star influent to treatment samples, most at concentrations close to their detection limits.

The Scanship treatment system successfully removed almost all pathogen indicators (>99%) and most classical pollutants, metals, and organics. Two pathogen indicators, enterococci and *E. coli*, were not detected in any of the 15 effluent treatment samples, while one indicator, fecal coliform, was detected in 2 samples. The treatment system removed almost all BOD₅ (99%), COD (93%), total organic carbon (TOC) (94%), settleable residue (>99%) and TSS (99%). The treatment system reduced total phosphorus by 98%. Ammonia and total Kjeldahl nitrogen (TKN) results for this sampling episode were anomalous; therefore, EPA is unable to assess the performance of the Scanship treatment system for these analytes. The treatment system was highly efficient at removing particulate metals, and removed dissolved metals at an average of 50%. The treatment system removed most of the volatile and semivolatile organics to concentrations below detection levels.

The Scanship wastewater treatment system generates waste biosludge (excess biological mass from the treatment system's bioreactor). Waste biosludge is pumped to a double-bottom holding tank for overboard discharge outside of 12 nautical miles from shore. Most of the analytes detected in the waste biosludge were also detected in the influent to the treatment system. The presence of these constituents in waste biosludge suggests that these analytes are removed from the system in these waste streams.

On average, each person generated approximately 59 gallons of untreated sewage and graywater per day. The average discharge from the treatment system was also approximately 59 gallons of treated wastewater per person per day.